HIGHLY EXPLOSIVE Pyrotechnic Compositions

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Make Them,
How to
Use Them

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Highly Explosive Pyrotechnic Compositions:
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Warning

The pyrotechnic compositions covered in this manual are classified as highly explosive and are considered to be extremely hazardous. The materials used in their manufacture also represent hazards in themselves due to their flammability or toxicity.

None of the products in this manual should be manufactured or handled by persons who are not experienced in the handling of explosive and toxic materials. Whenever dealing with highly explosive or otherwise hazardous materials, special precautions must be followed in accordance with industry standards for experimentation and production. Failure to strictly follow such indus-

try standards may result in harm to life and limb. Furthermore, the manufacture of the products in this manual is illegal.

The author and publisher disclaim any liability from any damages or injuries of any type that a reader or user of the information contained within this manual may encounter from the use of said information. This manual is *for academic study only*.

Introduction

A pyrotechnical agent usually consists of an intimate mechanical mixture of one or several solid oxidizers with one or several solid fuels.

To this basic mixture might be added chemicals that function as binders, stabilizers, color producers or chemical agents to be vaporized and dispersed by the burning reaction.

Oxidizers used in pyrotechnics include chlorates, chromates, dichromates, iodates, nitrates, oxides, perchlorates, permanganates and sulfates.

Fuels cover a wide spectrum of materials, including metal powders, carbonaceous materials, and a number of exotic chemicals.

HIGHLY EXPLOSIVE PYROTECHNIC COMPOSITIONS

Some pyrotechnic mixtures, like many smoke compositions, are not explosive and may only represent varying degrees of fire hazards. But a large number of pyrotechnic mixtures are explosive. These mixtures can be divided into low explosives and high explosives.

The characteristics of the low explosive types are generally comparable to those of the well-known black powder, whereas the high explosive variants are of a more violent nature. A high explosive is an explosive that detonates. Detonation is the rapid, self-propagating decomposition of an explosive accompanied by a high pressure, high temperature wave that moves through the explosive at a very fast rate. Low explosives do not detonate but deflagrate. Deflagration is the rapid burning of particles of explosive, without the presence of oxygen, resulting from friction, impact, spark, or flame.

Of the highly explosive pyrotechnic mixtures that follow, some (such as thermite igniter) are low explosives, and some will propagate a detonation wave and therefore are high explosives. The most powerful of these variants will produce blast effects which are similar to those of a primary explosive like tetracene.

A typical highly explosive pyrotechnic mixture will have a critical weight at which it will explode from open burning. This weight may vary with the different mixtures from pounds

to micrograms. Below the critical weight, the mixture will burn strongly but will produce no blast effects. Under weak or partial confinement the critical weight will be reduced considerably and under strong confinement it will be extremely low. Confined in a steel pipe, all of these mixtures will explode violently by flame contact. A heavy pipe bomb containing 35 pounds of photoflash powder, which was examined by explosives experts at Fort Sill, Oklahoma, in 1963, was estimated to have a damage radius of one-fourth of a mile.

A number of these mixtures may also be set off with a blasting cap the same as any secondary high explosive.

The purpose of this manual is to provide the essential information for improvising and using highly explosive compounds, and their standard applications.

An appendix also summarizes results from experimental deflagration-to-detonation transfer (DDT) tests with ANFO. In this alternative detonation system, the heat of a nonexplosive pyrotechnic mixture (thermite) has been successfully used to detonate this very insensitive material.

Details on firing systems are not included in this manual, as they are already covered in many other books in print. Possible reference works are *Volumes 1-3* of *Improvised Munitions Black Book*, which cover all types of firing systems including thermite, thermite igniters, and ANFO.

CHAPTER 1

Materials

OXIDIZERS

Lead Superoxide
PbO_2

Synonyms: Color Index 77580, lead dioxide, lead (IV) oxide, lead oxide brown, lead peroxide.
Safety: Avoid inhalation. Long-time exposure can be harmful.

Potassium Chlorate
$KClO_3$

Synonyms: Berthollet salt, chlorate of potash, kaliumchlorat, oxymuriate of potash, pearl ash, potcrate, salt of tarter.

Safety: Avoid inhalation of dust. Do not heat. Store in a cool place separately from combustible materials. Contaminated clothing should be removed (highly flammable). Will ignite on contact with acids. Can undergo detonation on strong impact.
Note: Most compositions containing potassium chlorate can be ignited by contact with concentrated sulfuric acid.

Potassium Nitrate
KNO_3

Synonyms: Niter, nitre, saltpeter, vicknite.
Safety: Store separately from combustible materials. Do not heat. Avoid inhalation of smoke in case of fire.

Potassium Perchlorate
$KCLO_4$

Synonyms: Periodin, potassium hyperchloride.
Safety: Avoid inhalation of dust. Store separately from combustible materials. Contaminated clothing should be removed.

Notes on Oxidizers

All of the four oxidizers can be obtained through companies dealing with chemicals for laboratories. Some companies will issue the same chemicals in different degrees of purity. Since the low-grade version is nor-

mally of a purity higher than 99 percent, there is no specific reason for investing in the high-grade version for explosive purposes. Only make sure that the material is classified as "chemically pure."

The oxidizers can sometimes be obtained in the form of fine powder, but mostly they will be found as a crystalline solid. All of the formulas in this manual call for a fine powder. The crystals can be reduced to powder by grinding them in a mortar, or by any other method that will be found practical. This can be done safely as long as the oxidizers are not contaminated with any combustible materials.

Potassium chlorate is sometimes classified as an explosive in itself. The fact is that this chlorate can undergo detonation on very strong impact, but no detonation occurs with a number 8 blasting cap. When detonation of pure potassium chlorate occurs, it is always a partial detonation. Therefore, the material can not be used as an effective explosive even when a boost charge is used to ignite it. If the material is ground by hand, there is no danger of an explosion.

If contaminated with a fuel-type material, none of the oxidizers will be safe to manipulate, and in this respect potassium chlorate is by far the most dangerous. Although it contains less oxygen than potassium perchlorate, it is a much more powerful and hazardous oxidizer because it reacts at a lower temperature. It takes only a small per-

centage of combustible material, especially red phosphorus or sulphur, to make it unstable so that any attempt to grind it will result in an explosion or fire.

FUELS

Aluminum, Powder

Al

Synonyms: Aluminum flake, aluminum metallic powder, atomized aluminum, Color Index 77000, dark pyro aluminum.
Safety: Avoid inhalation. Combustible.
Note: For explosive purposes, the best type of aluminum powder is dark pyro aluminum, but any type of chemically pure aluminum powder will work.

Antimony Trisulfide

Sb_2S_3

Synonyms: Antimonous sulfide, antimony glance, antimony orange, antimony sulfide, Color Index 77060, crimson antimony, needle antimony.
Safety: Avoid inhalation of dust. Do not heat. Will react with water, steam, or acids with the formation of toxic and flammable vapors.

Lead Thiocyanate
$Pb(SCN)_2$

Synonym: Lead sulfocyanate.
Safety: Avoid inhalation of dust and contact with skin. Do not heat.
Note: Lead thiocyanate is normally used only in combination with other fuels to increase the volume of the combustion gases.

Magnesium, Powder
Mg

Synonyms: None.
Safety: Avoid inhalation of dust. Flammable. Will react with water forming flammable gas.

Potassium Picrate
$C_6H_2KNO_7$

Synonym: Potassium-2,4,6-trinitrophenoxide.
Safety: A shock-sensitive high explosive. Can detonate on strong impact. Do not heat.

Red Phosphorus
P

Synonym: Amorphous phosphorus.
Safety: Nontoxic. Flammable. A strong sensitizer of many types of explosives. Avoid contamination of any other material with red phosphorus.

Note: Red phosphorus is insoluble in most liquids.

Salicylic Acid
$C_7H_6O_3$

Synonyms: 2-hydroxybenzoic acid, keralyt, orthohydroxybenzoic acid.
Safety: Avoid inhalation. A skin and eye irritant. Dust forms explosive mix in air.

Sulfur
S

Synonyms: Bensulfoid, collokit, flowers of sulphur, sulfur flour, sulfur flower, sulphur.
Safety: Nontoxic. Combustible. Dust forms explosive mix in air.

Titanium, Powder
Ti

Synonyms: None.
Safety: Nontoxic. Combustible.

Titanium Hydride, Powder
TiH

Synonyms: None.
Safety: Avoid inhalation of dust. Will react with water forming flammable gas.

Wood, Powder

Note: Should have the consistency of flour. Wood is normally used only in combinations with other fuels to give the powder a looser density.

Zirconium, Powder

Zr

Synonyms: None.
Safety: Highly flammable. Zirconium powder represents the most severe fire hazard when moist (up to 20 percent water). The powder must be kept absolutely dry or completely wet.

Notes on Fuels

Most of the fuels can be obtained from the same sources as the oxidizers. Potassium picrate might be difficult to obtain, as it is classified as an explosive.

The materials will normally be available as powders and will require no modification before mixing.

STABILIZERS

Ether

$C_4H_{10}O$

Synonym: Diethyl ether.
Safety: Highly flammable. Vapors are anaes-

thetic and explosive in high concentrations. Avoid buildup of vapors in working area.

Ethyl Alcohol
C_2H_6O

Synonyms: Alcohol, ethanol, grain alcohol.
Safety: Flammable.

Sodium Bicarbonate
$NaHCO_3$

Synonyms: Baking soda, bicarbonate of soda, soda mint, jusonin, monosodium carbonate, sodium hydrogen carbonate.
Safety: Nontoxic.

TOXIC AGENTS

Selenium, Powder
Se

Synonyms: Color Index 77805, colloidal selenium, elemental selenium, selenium dust, selenium metal powder, vandex.
Safety: Poisonous if inhaled or ingested. Avoid any contact with skin; wash contaminated skin with water. The toxic effects of selenium are most distinct in long-time exposure.

CHAPTER 2

Powders

The 13 types of powders listed below are capable of undergoing high-order detonation upon ignition by a brisk flame. The critical weight for detonation by open burning has not been established for all of the compositions, and tests have often resulted in different results. It is therefore not recommended to attempt detonation in nonconfining containers unless a detonator is used.

The blast and fragmention effect produced by these powders is considerably more destructive than that of a low explosive. In addition, some of these compositions will cause large fireballs and flashes of high intensity due to the afterburning of metal

particles. A TNT equivalence is only known for some of these powders, but compositions one and two appear to be the most powerful.

It is essential that these powders are always handled with great care and according to the safety rules.

1) 67 percent potassium perchlorate
33 percent titanium hydride
Standard Uses: High-energy igniter. Instantaneous squib.
Note: Can be applied as detonator charge for secondary high explosives.

2) 60 percent potassium perchlorate
40 percent zirconium
Standard Uses: High-energy igniter. Instantaneous squib.
Note: Can be applied as detonator charge for secondary high explosives.

3) 75 percent lead superoxide
25 percent titanium
Standard Uses: High-energy igniter. Instantaneous squib.

4) 80 percent lead superoxide
20 percent zirconium hydride
Standard Uses: High-energy igniter. Instantaneous squib.

5) 66.70 percent potassium perchlorate
33.30 percent titanium

Standard Uses: Igniter. Miniature pyrotechnic igniter.
TNT Equivalence: 75 percent

6) 45 percent potassium perchlorate
22 percent salicylic acid
28 percent potassium picrate
5 percent potassium nitrate
Standard Uses: Flash and report. Professionally made salutes.
Note: The only known flash powder without metal.

7) 45 percent potassium chlorate
22 percent antimony sulfide
33 percent lead thiocyanate
Standard Use: Stab primer composition.
Note: Very sensitive to impact. High density will increase sensitivity.

8) 67.50 percent potassium perchlorate
16.25 percent aluminum
16.25 percent antimony sulfide
Standard Uses: Flash and report. Military salutes.
Note: Critical weight for open burning is less than one gram.

9) 60 percent potassium perchlorate
40 percent aluminum
Standard Uses: Flash and report. Professionally made salutes.
TNT Equivalence: 60 percent.

10) 50 percent potassium chlorate
25 percent aluminum
25 percent sulfur
Standard Uses: Flash and report. Professionally made salutes.

11) 60 percent potassium perchlorate
40 percent magnesium
Standard Uses: Photoflash powder. Ejection charge for aerial photography. Burster charge in chemical grenades.
Note: This composition will produce an intense flash of visible and ultraviolet light.

12) 57 percent potassium perchlorate
38 percent sulfur
5 percent wood dust
Standard Uses: Report. Professionally made salutes.

13) 85 percent potassium chlorate
15 percent sulfur
Standard Uses: Report composition. Blasting agent.

NOTE: All percentages are by weight.

MANUFACTURE

All of the powders are made by simple dry mixing. None of them should be mixed wet, as most of them are water reactive and might

ignite spontaneously in a moist state. (Compositions containing magnesium are especially dangerous in this respect.)

When possible, the oxidizers should be freshly ground. The components can be mixed by stirring in an open container or by tumbling in a closed container. The mixing process should last a minimum of 20 minutes to obtain an intimately mixed powder.

In industrial production, these compositions are normally mixed in remote-controlled blenders and, whenever possible, in the actual bomb casing. Oxidizers and fuels are loaded separately into the casing in alternating layers and then mixed by tumbling or vibration. This process is desirable because it eliminates the dangers during loading and because handling the raw explosive is considerably more dangerous than handling loaded items.

INITIATION

All of the powders should be used under strong confinement when ignited by flame.

Most of the powders are spark sensitive, especially those containing potassium chlorate, but to guarantee ignition a small first-fire charge must be used. A small bag containing black powder is placed in the capped end of a heavy pipe (2-inch pipes are recommended as a minimum size), or the whole end section can be filled with black powder. A

chemical delay device can be placed in the powder bag, or it can be connected to a fuse or an electrical firing system. The pipe is then filled with the highly explosive powder and capped securely. The powder should be tamped in the pipe but not compressed hard, as it might not detonate.

For large charges, empty propane bottles or similar containers may be used.

Compositions 2, 5, 7, and 9 can be detonated without confinement if ignited with a number 8 blasting cap.

PERFORMANCES

It is recommended that the explosives be used for light blasting operations and anti-personnel fragmentation bombs. Their use for breaching and cutting in metal is not recommended.

CHAPTER 3

Safety on Powders

The majority of all accidents with pyrotechnic mixtures are caused by friction. Eliminating this source of accidental ignition will greatly increase safety. Only wooden tools should be used for mixing and loading. Strictly avoid scraping the explosive between two metal surfaces.

Static electricity is another hazard that should not be ignored in the handling of sensitive explosives and especially when handling the metallized powders covered by this volume. Dangerous levels of static electricity can be generated in any object of a conductive nature, including the human body, when it is insulated from the ground by a noncon-

ductive material. Static electricity may also build up on the surfaces of some insulating materials.

The basic countermeasure is to avoid such insulating materials as much as possible in the production of sensitive explosives. In this way, static electricity will be continuously discharged into the ground before building up to a dangerous level. Under ideal circumstances, any conductive object involved in the production, including persons, should be connected to the ground with a thin copper wire.

GENERAL SAFETY RULES

1) Protect explosive against friction and shock.
2) Protect explosive against any source of fire, sparks, and strong heat.
3) Protect explosive against moisture.
4) Protect explosive against discharges of static electricity.
   a) Avoid use of synthetic materials as much as possible.
   b) Footwear and gloves should be made of a conductive material.
   c) Electrical blenders or other machines should be grounded.
5) Mix several small batches instead of one large.
6) Keep large amounts of water at hand.

7) Wear eye protectives, gloves, and a dust mask during work.
8) Avoid storing explosive longer than absolutely necessary.

The Sulfur-Chlorate Combination

Special attention must be given to mixtures of ordinary sulfur and potassium chlorate. Ordinary sulfur may contain acid products, or it may react with air to form sulfur dioxide. This will make the mixture extremely sensitive and if it is stored for a prolonged time, it might explode spontaneously.

The high sensitivity of this combination is applied in some types of improvised impact-sensitive grenades, but generally it should be considered too hazardous to handle.

It is strongly recommended that sulfur flour be substituted for normal sulfur in mixtures with potassium chlorate. Sulfur flour is an almost white and special pure type of sulfur that is free of acid products and has a higher ignition temperature than other types of sulfur.

The addition of sodium bicarbonate in very small amounts will also make the mixture more stable.

CHAPTER 4

Armstrong's Explosive

The mixture of potassium chlorate and red phosphorus, known as Armstrong's Explosive, is probably the most unique of all pyrotechnic compositions. It can be mixed and installed safely when wet, and when it becomes dry it will detonate on impact or slight pressure with a dynamite-like effect.

In a relatively insensitive version containing solid stabilizers like chalk, this explosive was previously applied in small report items like paper caps. But even in such mixtures, Armstrong's Explosive can be dangerous to handle because it is sensitive to impact and sympathetic detonation. Even small-report items like paper caps, each containing a frac-

tion of a gram of Armstrong's Explosive, have caused death and destruction in accidental explosions. When large numbers of paper caps are tightly packed in containers, they may often detonate like a single uniform mass of explosive. Today the use of Armstrong's Explosive is generally avoided in the pyrotechnic industry, but it has occasionally drawn the attention of weapons designers as a main charge in land mines.

The variant of Armstrong's Explosive that is best applied in an unconventional warfare situation is a mixture of 80 percent potassium chlorate and 20 percent red phosphorus by volume.

A liquid stabilizer must always be added to these two components before mixing. Any attempt to dry-mix potassium chlorate and red phosphorus will result in an accidental explosion.

When mixing a small amount of explosive, water can be used as the stabilizer. For larger amounts, a more volatile stabilizer like alcohol or ether must be used because water might not evaporate fast enough from the charge.

MANUFACTURE

CAUTION: Do not attempt to dry mix this explosive.

1) Place eight parts of powdered potassium

chlorate in an open container and add alcohol or ether until the chlorate is completely soaked.

2) Add two parts of red phosphorus to the moistened chlorate and stir until intimately mixed. The explosive should have a porridge-like consistency during mixing; if necessary, add more of the stabilizer.

3) Install the moist explosive where it is to be detonated. When the stabilizer has evaporated, the explosive will have a solid consistency and be dark red in color. **CAUTION:** Do not attempt to handle dry explosives.

DETONATION

Armstrong's Explosive may be detonated in one of three ways:

Chemical-Only Booby Trap

This variant of Armstrong's Explosive is only surpassed in sensitivity by touch-sensitive explosives like ammonium nitrogen triiodine (contact explosive) and may therefore be installed in such a way that enemy personnel will accidently apply pressure to the charge.

One possible scenario is to install the explosive in a room behind a door. When an

attempt is made to open the door, the pressure or impact will set off the charge. If ether is used as the stabilizer and the explosive is installed in a closed room, a secondary vapor explosion may add to the destruction.

Conventional Explosive

Armstrong's Explosive can be detonated with a blasting cap and an electrical firing system. A small pipe bomb using any type of explosive filler may be used instead of a regular blasting cap.

Flame-Sensitive High Explosive

Armstrong's Explosive is flame sensitive and can be detonated with a delay incendiary.

CRITICAL WEIGHT

The critical weight of Armstrong's Explosive is ultra low, and therefore no confinement is necessary.

PERFORMANCE

An exact TNT equivalence is not known, but the blast effect is normally compared to that of dynamite.

SAFETY

1) Do not attempt to dry mix potassium chlorate and red phosphorus.

2) Do not attempt to handle Armstrong's Explosive when dry.
3) Only work with ether in a well-ventilated area.
4) Discard or carefully clean any equipment contaminated with Armstrong's Explosive.

CHAPTER 5

Selenium Dioxide

Several types of metal compounds, including some types of oxides and dioxides, are effective toxic agents if they are dispersed as a smoke or an aerosol. Furthermore, some of these compounds are relatively easily generated by including the elemental metal in incendiary or explosive compositions.

Cadmium has been used as an ingredient in incendiary compositions because the cadmium oxide smoke given off by the burning incendiary will act as a powerful lung irritant comparable with phosgene.

The basic incendiary mixture may be a modified thermite composition, such as the following:

44.20 percent iron oxide
29.40 percent barium nitrate
15.70 percent aluminum, granular
8.80 percent aluminum, powder
1.90 percent sulfur

To this mixture can be added up to 20 percent by weight of cadmium metal in the form of powder or wire, and the composition can be ignited with a standard thermite igniter of 75 percent barium chromate and 25 percent magnesium.

Such a material will typically be applied in an incendiary weapon designed primarily to start a fire, and with a secondary toxic effect to interfere with fire fighting activities.

An aerosol of similar toxicity may be generated by including relatively low-toxic selenium metal powder into the explosive composition. When involved in the detonation, the selenium will transform into selenium dioxide and be dispersed as a fine aerosol by the blast wave. Selenium dioxide is a powerful irritant that will attack the respiratory system, skin, and eyes to cause multiple effects.

MANUFACTURE

Add 5 percent by volume of selenium

powder to any type of highly explosive compound. Mix the components until the selenium is intimately mixed with the explosive.

INITIATION

Follow the existing procedure for the type of explosive used.

PERFORMANCE

Selenium weapons are best used in a closed or semi-closed area as combined explosives and toxic weapons. In the open, the toxic effect of selenium dioxide will probably be ineffective, unless it is used on a large scale.

SAFETY

1) Avoid inhalation and skin contact with selenium powder.
2) Consider all precautions for the type of explosive used.
3) Do not enter the target area after initiation.

Thermic Detonation

Experimental research has been done with thermic detonation of ANFO and closely-related explosives with a pyrotechnic incendiary in the attempt to develop a highly shock-insensitive detonation system. It has been established that ANFO can be detonated by thermite under strong confinement.

Burning thermite is capable of igniting ANFO and causing it to deflagrate. If the ignition takes place under strong confinement, the combustion gases produced by the burning will cause an enormous buildup of heat and pressure, which in turn will accelerate the burning process further—a process that will lead to the formation of shock waves and

detonation of the ANFO charge after a few seconds. This has been done only in an experimental stage, but the following guidelines have been established:

- The ANFO and the igniter charge must be placed under strong confinement like a heavy pipe with screw caps.

- The liquid metal produced by the burning thermite must come in direct contact with the ANFO.

- The ANFO must not be pressed into the container. If it is compressed beyond a certain density, it cannot be detonated by fire.

APPENDIX II

Recommended Reading

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Highly Explosive Pyrotechnic Compositions provides essential information for improvising and using highly explosive compounds, including their manufacture, detonation, and performances. Covered in detail are Armstrong's Explosive, a mixture of potassium chlorate and red phosphorus that produces dynamite-like results, and selenium dioxide, a powerful irritant that affects the respiratory system, skin, and eyes. Although safety precautions are outlined throughout, the pyrotechnical compositions covered herein are considered to be extremely hazardous. Therefore, this manual is *for academic study only*.

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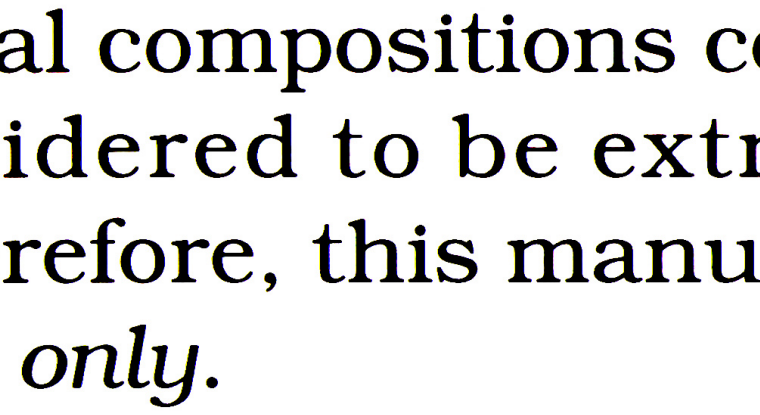

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